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ABSTRACT

Transformations in the French metalworking industries have given rise to numerous studies on employment and job content in metallurgy over the past decade. One study related technical transformations to changes in the skills content of certain categories of workers. Although automation results in the elimination of certain know-how belonging to an earlier phase of technical development, the analysis of robotization is no longer reduced to a simple robot-operator substitution, since the robot can never be a perfect substitute for the human operator. A series of studies in 1980-84 attempted to consider the role of the firms' economic situation in technological and organizational decision making. Numerical control appears to accentuate the polarization between preparation and manufacture and leaves open the possibility of assigning activities to different categories of workers. A series of studies in 1986-87 resulted in an "upgrading" of the role of the shop, the place where production requirements are brought together. Although there are examples of the Japanese "kanban" type in the French automobile industry, manufacturers seem to prefer investing in state-of-the-art technology, such as industrial automation or computerization. A comparison of French and Japanese experience in the machine tool sector shows a Japanese flexibility due to the different nature of occupational categories in France and Japan. (22 references) (YLB)

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Changing Skills in Metalworking Industries: A Review of Research

Transformations in the French metalworking industries have given rise to numerous studies on employment and job content in metallurgy over the past decade. The following review of that research is based on a more extensive survey recently carried out in the context of a forecasting study commissioned by the government and the employers organisations in the metal working industries [1]. A number of the studies deal with the transformations themselves, while others attempt to shed light on the problems encountered in recent years in two critical sectors by comparing conditions in France and Japan.

THE POLARISATION OF SKILLS

THE first of these studies [Bouchut et al. 1980] relates technical transformations to changes in the skills content of certain categories of workers. The fact that machines are increasingly fed and operated automatically has led to regrouping the feeding maneuvers with the previous stage of the mechanised labour carried out by machine operators. By contrast, maintenance work tends to be broken up into very simplified, standard operations on the one hand and sophisticated ones on the other. This

process of "skills redefinition" also affects programming technicians, whose work is divided into simple coding operations and complicated new tasks of programming and optimisation involving new categories of workers such as computer technicians.

In this context, the automation of work results in the elimination of certain know-how belonging to an earlier phase of technical development. In the operation of numerically controlled (CNC) machines, for example, the work of preparing the programmes becomes crucial, while the skilled operative's knowledge is no longer necessary. In the iron and steel industry, the development of mechanisation and early forms of automation has led to the disappearance of a certain concrete professional knowledge rooted in artisanal practices; this has been

[1] J. J. Micheliere, *Travail et emploi dans la Métallurgie*, CEREQ Document de Travail n° 57 (June 1980).

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transformed into another type of knowledge which functions algorithmically and can be integrated into current scientific and technical expertise.

Since 1983, however, the orientation has begun to shift. The necessary forms of knowledge are subject to more precise definitions, and the analysis of robotisation is no longer reduced to a simple robot-operator substitution because it is recognised that the robot can never be a perfect substitute for the human operator [Bouchut et al. 1983]. On the economic level, these new analyses bring out the inappropriateness of investment choices in robotics which do not take into account various production-cost factors such as waiting periods, delays, stocking, retouching, or wastes of energy and raw materials. Relations between general economic conditions and automation are likewise held to be too rigid, since these economic conditions clearly permit several forms of automation, yet these do not all have the same impact on the organisation of human labour and the kinds of knowledge required [Barcet and Mercier 1983].

NEW TECHNOLOGIES AND LABOUR

A SECOND series of studies carried out by CERQ and the Laboratory for the Economics and Sociology of Labour (LEST) in Aix-en-Provence between 1980 and 1984 attempts to take into consideration the role of the firms' economic situation in technological and organisational decision-making.

The most representative example of skilled industrial labour is undoubtedly metal machining. Over the past ten years, with the spread of numerical control, this work has been modified considerably. Like all forms of automation, numerical control is based on the separation between the elaboration and transmission of instructions to the machine on the one hand and the machine's carrying out of the material operations on the other. As a result, numerical control tends to accentuate the polarisation of functions between preparation and manufacture and thus threatens the qualification of the operator, who does not participate in programming.

In-depth investigations into the work of these operators carried out in the early 1980s [Bertrand 1984; Cavestro 1984] show, however, that preparatory work always allows the operator a certain autonomy. Indeed, it is impossible to eliminate all the unknowns, and these can only increase when the series are small and the parts complex. The traditional machining competencies do not tend to disappear automatically, but the new programming competencies fall into different occupational categories than those of skilled operatives. The inquiries conducted at LEST when numerical control was first being introduced [Maurice et al. 1986] also bring out the crucial nature of the implementation of the programming function. The process pits the planning and programming personnel against those of the shop, and in many firms, it is most often the setters, planners, programmers, or, in certain cases, shop technicians who see their work upgraded. In other words, in-shop programming was not practised in any of the firms investigated. The comparative studies between France and Japan will provide the beginnings of an explanation for this situation.

In contrast to numerical control, robotics or techniques of control by programmable automation or microprocessor generally lend themselves to repetitive work carried out under strong time constraints, such as on the assembly line. The difficulties encountered in automating this kind

of work are dealt with in several studies which bring out aspects sometimes neglected by those responsible for conceptualising automated equipment. Thus, unskilled work is often represented as repetitive and continuous in the sense that it endlessly repeats the same operations. But in fact, this repetitiveness and continuity only exist in the absence of technical incidents, variations in the size of the labour force, fluctuations in the nature of the material being worked, and so forth [Chave et al. 1978]. As the ergonomists point out, real work is never identical to the operations assigned to unskilled workers, whether this involves the assembly line or the operation of mechanised equipment [Daniellou et al. 1983].

In addition, unskilled labour entails other kinds of labour around it, notably the supervision, retouching, setting or repairing of mechanised equipment. Thus automation can affect all or part of these activities but still leave open the possibility of assigning the rest to different categories of workers.

Surveys conducted in the early 1980s [Merchiers 1984] bring out certain constants: the emergence at the production stage of operator-supervisors who carry out part of the maintenance and setting work; a related trend toward the disappearance of the setters, who often constitute an intermediate category between maintenance and production; multiplication of levels of upkeep, and the growing importance of technicians, especially in the programming of control systems. The functional integration of the production-supervision-maintenance model runs up against the limitations of automation, however.

If, as is sometimes said, automation gives rise to the "breakdown society", this is undoubtedly because the traditional causes of dysfunction have not disappeared (irregularities in the raw materials, defects in the functioning of the equipment), and the introduction of new technologies often leads to hybrid ensembles mixing old and new elements. The result is what ergonomists call "downgraded operation." To deal with this situation, the operators have to seek out the necessary information themselves, in other words, to anticipate the course of the operations; this capacity would seem to depend on vocational experience but also on training. [Rosenvall and Troussier 1987].

The development of maintenance [Denis 1985] also comes under the general goals of productivity and profitability, which translate into greater demand for continuity in the production process. The conception of the breakdown as an "accident" with no particular significance gives way to that of the interrelationship between the breakdown, the nature of the equipment, and the cost of maintenance. The breakdown rate is taken to reflect the dependability of the equipment. The spread of industrial computer technology also contributes to the planning and structuring of maintenance through the development of mechanisms for auto-command, for signaling breakdowns, for assisting in diagnosis and repair. Finally, better relations between departments tend to challenge the existing separations and to reduce antagonisms between maintenance and production. However, these inquiries into the engineering and process industries do not confirm the general thesis of the polarisation of maintenance skills. Rather, they suggest that continuous, complementary interventions take place, within the maintenance departments and between the agents of these departments and the production operators, who are responsible for providing initial indications about equipment performance, i.e., for carrying out the most basic tasks of maintenance and repair.

THE UPGRADING OF THE SHOP

A FINAL series of studies carried out in 1986-1987 by several teams coordinated by CERQ [Bercot et al. 1988, 1989] was aimed at redefining the role of the operative and technician categories in situations of industrial change; at the same time it identified the practical knowledge that they entail in order to provide information for training policy-makers. One of the main results of this research relates to the "upgrading" of the role of the shop, which is now recognised as the place where production requirements are brought together. These new requirements concern the dependability of technical equipment (for maximum avoidance of breakdowns and unknowns), the quality of the final product (which presupposes auto-command during manufacturing itself), and flexibility of organisation (to ensure compatibility between the delivery of orders "just in time" and optimal use of production capacities).

The role of the shop is also being upgraded on the level of practical knowledge, because it is there that concrete expertise about the functioning and correction of installations is formed, and this kind of knowledge is particularly valued by departments responsible for conception and innovation [Zarfian 1988]. The distinction between operatives and technicians thus becomes more flexible: technicians take charge of production by shift, and operatives participate in the elaboration of technical changes. On the level of practical knowledge and training, this research shows that, with the upgrading of the shop, the operatives' knowledge of production processes, far from diminishing, becomes richer. The operative, now an "operative-technician," is also the expert on what takes place at his work station.

AUTOMATION IN THE AUTOMOBILE INDUSTRY AND THE FUTURE OF TAYLORISM

BETWEEN 1983 and 1987, automobile construction was second only to the iron and steel industry as the sector most affected by employment cutbacks, especially for unskilled labour. To some extent, however, technical functions were less affected than those of sales and administration [Choffel and Kramarz 1988]. It is thus reasonable to ask whether the Taylorist model of mass production has not broken down [Kern and Schumann 1984].

The first wave of automation, launched in the automobile industry in the 1950s, essentially involved machining, which was partly carried out by machine transfers. The second wave, however, put technical means at the disposal of the current imperatives of flexibility and profitability, thus making the mechanisation of previously manual operations both possible and profitable [Freyssenet et al. 1985]. From these developments there emerged a new job profile: that of the operator, who combines the supervision of equipment -- a manufacturing activity -- with the first level of maintenance, and thus collaborates with technician-level maintenance personnel. The imperatives of flexibility and profitability also contribute to modifying the overall production system, as shown by a comparative study of the automobile industries in France and Japan [Jacot et al. 1990].

The specificity of the Japanese style of production and management is best seen in the "Toyota system." This basically consists of measures aimed at simplifying the organisation and economising on resources through a system of so-called manufacturing *kanbans*. This system permits "just-in-time" production through the use of labels (*kanban* means "label" or "card," in this case attached to a container of parts) to transmit the manufacturing order from one work station to another situated upstream. Thus the second station only receives manufacturing orders corresponding to the needs of the first when these needs become apparent. The Toyota production system, which also incorporates many other measures of standardisation, machine layout and quality control, is aimed at simplifying and improving the manufacturing process by bringing management down to the production level. It is here, for example, that the *kanban's* organising function comes into play, since the virtual disappearance of buffer stocks reveals problems of machine dependability, of labour skills, of the quality of the raw materials, and so forth. The "just-in-time" principle thus serves as a powerful means of rationalisation.

In France, although there are methods of the *kanban* type, manufacturers seem prefer investing in state-of-the-art technology such as industrial automation or computerisation. Production management is most often organised around MRP (Management Resources Planning) procedures, which are based on statistical assessments of necessary production resources taking into account random fluctuations in demand. This trend can be explained on the one hand by widespread computerisation of the firms' management apparatus and on the other, by the fact that such an approach is better suited to the hierarchical, centralised organisation inspired by Taylorism.

OCCUPATIONAL CATEGORIES AND COMPETITIVENESS: THE CASE OF THE MACHINE TOOL

THE machine-tool sector occupies a central position in the metalworking industry because of its role in the creation and diffusion of new production norms. While France has never been one of the major machine-tool producers, the situation declined sharply from 1974 on. The fact that the government's recovery plan of 1981 is the ninth to be instituted since the Second World War demonstrates the industry's structural problems.

This most recent plan is intended to permit major changes in the nature of the product by encouraging the manufacture of CNC machines and machining centres [Hillaud and Podevin 1985]. A certain improvement was noted in 1988, but on the world scale, the sector has dropped from fifth to eighth or ninth place, and with increasing mergers, the two hundred existing firms may well dwindle to fifty or even twenty in the coming years.

Such a situation stands in marked contrast to Japan's resounding success. A comparative study [Maurice et al. 1988] sheds light on the Japanese experience in the field, which they call "mechatronics" to underscore the fusion of innovative technologies from engineering and electronics alike. This capacity to integrate new technologies is combined with a certain prudence where automation is concerned, and the resulting search for alternatives to total automation avoids the violent kinds of technological disruptions that have been encountered in France. It also relies on increasing the competencies of the personnel.

which permits the transformation of existing machines and even the creation of new ones.

The main explanation for this flexibility is to be found in the different nature of occupational categories in France and Japan. In France, the notion of the "cadre" plays an important role, but the institutional definitions of this category vary. According to the collective conventions, membership in the category is determined by status in the firm. Supervisors and technicians are excluded [Groux 1983] and are thus clearly distinguished from engineers, who are always classified as cadres. In Japan, by contrast, not all engineers have the status of cadre: a significant proportion of them are classified as employees along with the technicians, at least during the first part of their careers. In other words, the technician category includes a part of the beginning engineers, who can be assigned to tasks of workers as well as those of "technicians" in the French sense of the term, before moving on to tasks that require technical expertise or the assuming of a supervisory function. The other technicians fall into a kind of intermediate category between skilled operatives and engineers because that have not acquired the necessary competencies, through initial training or career experience, to assume engineering tasks.

The consequences of these differences are clearly visible in the way that Japanese shop personnel acquire competencies. The operators working on CNC machines learn programming through courses organised by the engineers and through on-the-job training with the programmers. As the operators master programming, the engineers can devote increasing time to the technical

improvement of the machines or the optimisation of certain complicated programmes. Such a form of knowledge transfer reflects the relations of reciprocity found in most Japanese groups and a kind of organisation that favors overlapping of functions or tasks through the flexible definition of assignments. As a result, the authors of this study argue, the question often raised in France about bringing the shop and its support units closer together does not even exist in Japan.

CONCLUSION

IN light of the Japanese experience, it can be seen that the importance given to the technician category in French firms is characteristic of the French solution to the problem of relations between the shop and its support units. The progressive establishment of this occupational track in the educational system is also particular to France, as is shown in a still-timely report commissioned by UNESCO in 1981 [French 1981]. This category replaces the promotion of skilled operatives, who previously attained the status of technicians in the support units. But it also allows the maintenance of a certain relationship between workers and operators in the shop and engineers by bridging somewhat the occupational and social distances that separate these two very different categories.

Article written by Jacques Merchiers

(Translation by Miriam Rosen)

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